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PROGRESS IN TELEMATICS APPLICATIONS FOR ROAD TRANSPORT IN EUROPE

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TO THE HIGH LEVEL GROUP ON

ROAD TRANSPORT TELEMATICS

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Commission European Union - DG XlII.C.6 -
X400 Yvonne Demory-
Thyssens;DG13;BXL;CEC;RTT;BE

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CONTENTS

ACRONYMS USED IN THE TEXT

AID	Automatic Incident Detection
ALERT-C	Advice and problem Location for European Road Traffic *(Protocol for RDS-TMC traffic messages)*
ATT	Advanced Transport Telematics
AVL	Automatic Vehicle Location
CCTV	Closed Circuit Television
CARD-ME	Concerted Action for Research on Demand Management in Europe *(Concerted action with EL' Member States)*
CARMlNAT	*CARin* MINerva ATlas *(RTT Service Operator)*
CEN	*Comite* Europeen de Normahsauon *(European Standards Organisation)*
CENELEC	Cormte Europeen de Normahsauon Electrotechnique *(European Standards Organisation)*
CEN TC 178	CEN Techmcal Committee 278 on Road Transport and Traffic Telematlcs
DATEX	Data Exchange *(DRIVE Research & development task force)*
DGPS	Differential Global Positioning System
DMRG	Dual Mode Route Guidance
DRG	Dynamic Route Guidance
DRIVE	Dedidcated Road Infrastructure for Vehicle safety in Europe (EU *Research & Development programmer)*
DSRC	Dedicated Short-Range Communications *(eg infrared or microwave beacons)*
DYNAGUIDE	Volvo Dynamic Route Guidance System
ECMT	The European Conference of Ministers for Transport
ECORTIS	European Co-ordmation for the implementation of RDS-'TMC Traffic Information Services
EDEN	European Data Exchange Network
ED1	Electronic Data Interchange
EDIFACT	Elecuomc Data Interchange for Administration, Commerce and Transport
ERTICO	European Road Transport Telematics Implementation Co-ordination Organisation
ETSI	Eupopean Telecommunications Standards Institute
EU	European Union
GDF	Geographic Data File
GPRS	General Packet Radio Service
GSM	Global Systems Mobile communications
HMI	Human-Machine Interface (*also* MMI *Man-Machine Interface)*
HT	Headway Time
HUD	Head Up Displays
ICC	Intelligent Cruise Control
INMARSAT	INternational MARitime SATellite
ISO	International Standardisation Organisation
LCD	Liquid Crystal Display
I.ED	Light Emitting Diodes
MAGIC	*Traffic Management action group advising the EU Motorway Working Group*
PT	Public Transport Priority
QARTET	Quadrilateral Advanced Research on Telematics for Environment and Transport *(DRIVE Research & Development project)*
KDS-TMC	Radio Data System Traffic Message Channel
R T T	Road Transport Telematics
SATIN	System Architecture and Traffic Control Integration *(DRIVE Research & development task force)*
SOCRATES	System of Cellular Radio for Traffic Efficiency and Safety
TELTEN	Telematics implementation on the Trans-European Road Network
TERN	Trans-European Road Network
UTC	Urban Traffic Control
VMS	Variable Message Sign

PROGRESS IN TELEMATICS APPLICATIONS FOR ROAD TRANSPORT IN EUROPE

I. INTRODUCTION

In September 1995 the Council of Ministers requested the Commission' to submit a detailed report on the activities of the European Union in the field of Road Transport Telematics (RTT), including a cost-benefit analysis of the envisaged measures. This document is a response to that request. It contains the main results from the research and development work on Advanced Transport Telematics (ATT) in the road transport sector, together with the results from the main initiatives on early deployment.

As noted by the Council, the work on early deployment has been concerned primarily with the use of telematics on the Trans-European Road Network (TERN), the implementation of a Radio Data System Traffic Message Channel (RDS-TMC) for Europe and the development of automatic electronic tolling methods. However. there are other important aspects of RTT deployment that demand attention. This agenda is now the concern of the working group of senior officials from the Member States that has been established following the Council Resolution of 28 September 1995. The High Level Group is there to advise the Commission about the strategy and framework necessary to accelerate deployment of Road Transport Telematics in Europe. A strategy and action plan for RTT in Europe needs to be worked out by the Commission, through discussions with public and private partners (business and industry} and with transport users, taking full account of world-wide developments in this sector.

A key input to the process of strategy formulation is a thorough appreciation of the research which was sponsored under Second and Third European RTD Framework Programmes. The two programmes spanned the years 1989 to 1995 and became known as DRIVE I and DRIVE II. covering the penods 1989- 1991 and 1902- 1995 respectively. The main results of this R & D work and the parallel studies and first implementation projects for early deployment of RTT (TELTEN. ECORTIS. EDEN etc[2]) are presented in Chapter 11 of this report. The main RTT applications are grouped into six pnority areas. plus the common fictions and horizontal support actions that will hasten the deployment of RTT in all application areas.

Chapter III describes the results of the available evaluation work on RTT impacts and benefits arising from EU-funded projects. This is a response to the Council's request for information about cost / benefit studies on RTT. Finally, it should be noted that the subject of Road Transport Telematics is attracting a sreat deal of attention world-wide. There have now been two World Congresses held on Intelligent Transport Systems: the first in Paris in 1994. the second a year later in Yokohama, Japan in November 1995. The third will take place in Orlando. LISA during October 1996 Europe plays host to the 1997 event in Berlin.

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[1] Council Resolution 8493/95. adopted on 28 September 1995. OJ C264/1 of 11.10.95

[2] See Annex 1

II. EU ACHIEVEMENTS IN ROAD TRANSPORT TELEMATICS

A. DEMAND MANAGEMENT TRAFFIC OPERATION AND CONTROL

Throughout the European Union there is an urgent need for travel demand management, traffic operations and traffic control. on both the urban and inter-urban road networks. Various study groups and EU-sponsored projects have looked at the scope for deploying telematics to this end. The results of this work show that telematics can provide an effective means to manage the growing amount of traffic using the principal roads and motorways that make up the TERN and also to improve the situation in congested urban areas.

The main telematics applications in this domain can be grouped very broadly into urban and inter-urban applications. Very broadly. traffic management (traffic operation and control) is concerned with modifying driver behaviour to optimise traffic conditions as a whole. for example by smoothing traffic flow to make better use of existing capacity. Demand management goes further: it covers tools that have a potentially stronger impact on traffic conditions by seeking to influence the route choice of drivers, time of departure and even choice of mode.

A.1 Urban Traffic Management, Operation and Control

Urban Network signal control Several fully adaptive Urban Traffic Control (UTC) systems have been developed and tested. including a knowledge-based model. Particular strategies (gating. bus priority. off-peak speed control. pedestrian demand) have been assessed. and innovative systems to improve the UTC program using fuzzy logic and artificial intelligence have been developed. Where tested. benefits have been encouraging.

Co-ordination of successive traffic lights on a corridor to enhance traffic throughput and driver comfort was found to be effective in cities with "straightfonvard" street layouts (grid. large corridors) Other signal control strategies are being developed to give priority to collective transport services and emergency vehicles

Access control Access control to the city centre using automatic vehicle identification has been tested in the cities of Barcelona and Bologna based on digital images and licence number plate reading technology The social reaction was found to be positive (see Chapter III Section 1.1).

VMS (Variable Messane Signs)-based information The technology of VMS has progressed from illuminated signs and rotating planks/prisms to fibre-optics, Light Emitting Diodes (LED) and Liquid Crystal Display (LCD). and may be considered as mature Information to dnvers in cities and on pen-urban motorways through the use of VMS has been extensively evaluated by a number of local projects Parkking information systems using VMS have been trialled as a part of an Integrated urban traffic management strategy.

Integrated Urban Applications Various cities have been working towards a more integrated approach to the deployment of telematics systems in support of city-wide policies on congestion management, traffic and parking control and policies to achieve a change in travel mode. Through the work of the QUARTET project and the SATIN Task Force a system architecture for urban telematics applications has been developed and results are being made available to the relevant Standards Organisations (principally CEN Technical Committee 278 on Road Transport and Traffic Telematics but also ISO Technical Committee 204 on Transport Information and Control Systems).

A.2 Inter-urban Traffic Management, Operation and Control

Within the domain of inter-urban traffic operation and control, telematics is being deployed in support of incident management, VMS-based traffic management, ramp metering and short-term forecasting of journey times and traffic volumes. The possibilities have been studied as part of MAGIC and TELTEN (both initiatives of the EU Motorway Working Group)

The main outcome has been recommendations in the domain of traffic management on the Trans-European Road Network. In TELTEN2, a list of "basic" traffic management and information services was compiled, i.e. services that mainly affect the safety and time-efficiency of the road user. Arising from this work a broad consensus now exists amongst European road operators on three basic missions:

- Mission 1: keep the roads available and safe
- Mission 2: operate the traffic flows
- Mission 3: assist users and provide travel services.

This framework allows traffic management services to be developed for the TERN. for example emergency response. winter maintenance. lane control, speed management (or queue-tail protection). speed harmonisation. incident warning. ramp metering, event information. re-routing and network control.

VMS-based traffic control Traffic control for inter-urban networks has concentrated mainly on strategies for the use of Variable Message Signs to control, give warnings, advice and information Alternative legends and message formats have been tested. Guidelines for best practice have been developed and a library of messages was prepared for European standardisation. Special attention has been given to strategies for improved corridor and network management. Examples of services using VMS are lane control, speed management (or queue-tall protection). speed harmonisation. incident warning, event information and re-routing

Rampmetering Projects have investigated the impact on the adjacent road network of metering traffic on motorway access ramps. also the methods for integration of ramp metering with other traffic control measures

Camera Enforcement Methods of camera enforcement for speed control and automatic tolling enforcement on multi-lane motorways have been demonstrated

A.3 Emergency management

A rapid response by the agencies responsible for road network management can save lives and minimise the spread of traffic congestion. Telematics can support more rapid incident detection and secure reliable data on the location of any emergency. Closed Circuit Television (CCTV) is increasingly deployed.

GSM-based systems Systems to automatically initiate emergency response providing details of the severity and the location of the accident. and to warn subsequent traffic have been tested. They use commercially available techniques such as Differential Global Positioning System (DGPS) and a Geographic Data File (GDF) map database.

Drivers' special needs Guidelines for user requirements to help drivers with special needs. and a database on assistance systems have been developed

B. TRAVEL AND TRAFFIC INFORMATION

European projects have supported a threefold approach to satisfying user needs and requirements. (1) to provide the means to receive better travel information to enhance route choice, (2) to develop new sources of traffic information and data on the latest road and traffic/travel conditions: and (3) to prove degital map-based systems offering navigation and route guidance. In this context information includes details of current and forecast traffic and weather conditions. alternative transport options. including public transport. the availability of parking spaces and the location of hotels and restaurants. etc

B.1 Traveller information services

The collection and exchange of traffic and travel information is central to the task of delivering travel and traffic information services EU projects have been concerned with the basic building blocks to facilitate the operation of telematics-based systems This includes the organisational models and data exchange protocols tor establishing links between service providers and vanous information providers The latter include all the public transport operators. road authonties and parking companies

The first steps in providing access to on-linc information services have been achieved. including route planning based on real-ttme trattic information. public transport schedules and estimated arrival times. parking availability and travel time forecasts. and connections with park and nde

ERTICO - the European Road Transport Telematics Implementation Co-ordination Organisation - and ECMT - the European Conterence of Ministers for Transport - have jointly sutdied the institutional and legal issues associated with traveller information services and have made recommendations on contractual models for public-private partnerships

B.2 Radio Data System - Traffic Message Channel (RDS-TMC)

The RDS-TMC traffic information service has been validated and demonstrated in a number of projects and in some national sites. RDS-TMC is now regarded as an important traffic management tool in many countries because of its potential impact on safety. Its four main advantages are:

- users receive traffic information in their native language, wherever they drive in Europe
- users can restrict the information to the area or roads in which they are interested
- at up to 300 messages per 15 minutes, the potential number of transmitted messages is greatly enhanced over existing broadcast information
- users have quicker access to traffic information (they do not have to wait for traffic bulletins).

A Reference Position Document agreed by all actors provides the groundwork for defining a minimum-qualny European service. RDS-TMC is now the subject of a number of projects being funded from the Trans-European Network (Transport) budget. It is expected that most European countries will introduce RDS-TMC services during the next few years.

B.3 GSM-based traffic information services

Demonstrations by the SOCRATES consortium of Dynamic Route Guidance based on two-way communications using GSM or other cellular radio networks have led to the development of functional specifications for an open system architecture and common data protocols. In principle, SOCRATES is to support six applications: “dynamic route guidance”. “driver Information”. " emergency services". "parking information”, “public transport information” and “fleet management (automatic vehicle location)".
The growth of pan-European services will be helped by the implementation of a “General Packet Radio Service (GPRS) over the GSM mobile telephone network to provide for the transmission of traffic data The utility of GSM as a carrier for these services is further enhanced by the development of a functional specification for extending GSM transmissions into confined areas. including tunnels

B.4 Navigation and Route Guidance

Recommendations have been made on how to link Urban Traffic Control systems (UTC) and traffic information databases with dynamic route guidance, covering route guidance strategies. software specifications and minimum operational requirements

RDS-TMC based navigation and route guidance European projects have shown that potentially commercial route guidance systems like CARMINAT and DYNAGUIDE can be adapted to respond to dynamic information broadcast via RDS-TMC using the ALERT-C protocol. This has been formalised in a functional specification for Dual Mode Route Guidance (DMRG - static and dynamic) which is based on the integration of autonomous navigation, RDS-TMC and dynamic route guidance via beacons

GSM-based navigation and route guidance: Dynamic route guidance has been implemented in several test vehicles Current plans are to develop an operational route guidance system that can be marketed by 1998.

B.5 Ride matching and reservation

Software support for ride matching and reservation has been developed in many **EU countries in** recent years. The scope has often been widened to generating Public Transport alternatives as well

C. TOLLING, ELECTRONIC PAYMENT AND BOOKING

This domain covers all the activities related to the provision of technologies suitable for automatic debiting, including electronic payment of user charges and tolls for use of certain infrastructure: also the study of strategies and tools to be used for travel demand management.

A priority has been to develop and demonstrate multi-lane non-stop automatic tolling systems to be used on motorways. However, these same systems - based on the use of smart cards and an on-board unit managing the short-range communication link - can also be used for on-street and off-street parking payment and urban road pricing and congestion charging schemes. As such they represent a promising new approach to demand management for congested roads.

C.1 Concerted Action: CARD-ME

The CARD-ME initiative was launched in 1994. This is a concerted action involving the Commission and delegates of the Member States to achieve interoperability of tolling systems on the inter-urban road network. Emphasis has been placed on technical work and the development of enforcement. security and implementation strategies. Comparative studies between Member States which are at a different stage of developing electronic tolling systems are underway with the objective of developing an overall deployment strategy and action plan

C.2 Multi-lane non-stop automatic toll collection

Several demonstrations on inter-urban and urban motorways have proven that the technology for automatic transactions is viable and gives satisfactory results. Test sites in the EU programme were Goteborg. Thessaloniki Jonkoping and in Italy

The technica problems related to the complexity introduced by cars changing lanes and passing simultaneously are now resolved. The associated problems concerning automatic classification of the passing vehicles and automatic enforcement in case of non-compliance still require more work. How to handle non-equipped vehicles in cases where a separate lane is impossible to install is still an open issue.

C.3 Car Park booking and Guidance

The Lisbon project included a demonstration of the feasibility of combining tolling and charging using the Dedidcated Short-Range Communication (DSRC) link with othernon-tolling purposes. such as informing drivers about the availability or not of parking spaces in the city centre. This demonstration showed how the DSRC could support a system for drivers to reserve a parking space and even pay in advance during the trip to the city centre whilst being guided to the parking. This was achieved in part by use of a predictive algorithm using a dynamic assignment method to show parking space availability. This has proved a very useful tool for city authorities wanting to manage parking and car travel demand in their cities.

D. COMMERCIAL VEHICLE OPERATIONS

The creation of the single European market and radical changes in manufacturing practices over recent years have had a major impact on distribution throughout the European Union. Centralised manufacture and warehousing and just-in-time delivery schedules demand fast. flexible and reliable services. Telematics has a part to play in this. in support not only of the transport operation but also of the safe and efficient use of transport infrastructure, and the promotion of chain operations combining different transport modes.

The main systems are concerned with commercial vehicle fleet logistics and administrative processes. including electromc vehicle clearance at check-points, automated roadside safety inspection, on-board safety monitoring. hazardous goods incident notification and inter-modal transport and terminal management. Full integration of these features has still to be achieved. despite a recent market pull towards adopting telematics applications by the more forward-looking fleet operators.

D.l Commercial Freight and Fleet Management

Mobile data communication links are increasingly used between the driver or vehicle and a central controller using ten-estnal and satellite networks. Electronic Data Interchange (EDI) between the freight operator and the shipper is also gaining ground Real-time information and automatic identification systems which monitor the movements of load-units using Automatic Vehicle Location(AVL) can be used to warn traffic agents and their clients of any deviations and delays.

EC research funds have supported testing and evaluation of mobile data communications for commincations with drivers and EDI between freight operators and shippers or forwarders. in particular for their applicability and benefits to small and medium-sized companies. Specific functional specifications have been demonstrated

D.2 Hazardous Goods Incident Notification

Systems which monitor and control hazardous goods movements. focusing on liaison between commercial operators and national, regional and local administrations. A common European system has been defined for Dangerous Goods Transport monitoring and control on motorway corridors

D.3 Intermodal Transport and Terminal Management

Systems to trace unit loads through combined transport have been developed and validated on road and rail corridors. These technologies can be applied to freight centre operations. such as ports. airports and railhead distribution depots. serving multiple modes of transport. The technologies can also be used to trace unit loads through a combined transport operation involving multi-modal shipments.

E. COLLECTIVE TRANSPORT SERVICES

Advanced Transport Telematics for public transport covers all the activities related to collective transport of passengers. The key transport policy objective has been to generate a modal shift from private car to public transport and consequently reduce the number of vehicles needing to use the limited available road space Telematics can support that objective in various ways eg: applications directly serving the public transport customer (e.g. fare collection, real-time **information** etc.). those which assist the operator to improve service quality (e.g. bus priority systems, advanced Vehicle Scheduling and Control Systems, etc.) and those assisting the market to supply coherent, cost-effective products (architectures. data models and interfaces. etc.).

E.l Pre-trip and On-trip Information

Trip planning information systems Such systems. providing information for travellers in an interactive way have been demonstrated in Madrid and in Southampton for direct dialogue with the passengers.

Enquiry office terminals Sophisticated enquiry office terminals to be used by enquiry operators have been installed in Marseilles and Thessaloniki These systems provide mainly timetable information. tnp optimisation and tnp comparison between taxi. car and bus solutions. The calculated solution is based on an advanced algorithm able to take into account multi-modal trips with several transfers (pedestrian transport. bus. tram metro. car. etc.).

Real-time bus arrival time information systems Real-time bus arrival time information systems are intended essentially to enhance the degree of satisfaction of the Public Transport users Accuracy and reliability of such systems is therefore crucial in regaining the trust of travellers. Real-time bus amval time information systems have been shown to be appealing to a large number of users.

E.2 Public Transport Vehicle Priority

Appropnate priority to public transport vehicles can be obtained by modifying the road layout. or by influencing traffic lights at intersections by integration with urban traffic control thus reducing the time lost at those intersections Research shows that reducing the time lost at signalised intersections has a positive impact on travel time. (up to 30% less). and helps punctuality and regularity on bus lines, thereby improving the reliability of connections with other lines. a better balance of passenger loadings between vehicles. and improved vehicle utilisation. so that some vehicles are not needed at all.

E.3 Fare Collection Systems

Transport Telematics provides a growing number of options for flexibility in fare collection allowing operators to take a new approach to their business. A very wide range of technologies, ranging from the paper ticket over magnetic stripe tickets (low cohersive and high cohersive) to contact smart cards and contactless smart cards, are currently available and in use by different operators.

Results of EU funded research shows:

- Magnetic stripe is a mature technology perfectly suitable for single, multiple ride, and value stored tickets in autonomous companies. Low-level integration between different public transport operations can also be envisaged.
- Standard smart cards needing contact with the fare readers are not suitable for applications on board the vehicles They are only appropriate for the purchase of tickets in vending machines.
- The contactless proximity card offers a flexible solution for the future. suitable for multiple ride, stored value. and season tickets. allowing systematic validation without restriction.
- Price reductions due to mass production and standarisation are expected to reduce the card price to an acceptable level in the very near future.

As it appears now, a combination of magnetic technology for single tickets and proximity cards for season tickets seems to be the optimum solution. This solution will also provide the technical basis for full integration between multiple operators in any future payment scheme.

E.4 Demand-Responsive Services: Personalised Public Transit

All existing demand-responsive systems are “manually” operated i.e. an operator receives telephone calls from the passengers, and estimates the optimum journeys taking into account the different demands and sends the vehicles on line.
More accurate optimisation can be reached by automating the system and calculating the optimum journeys by means of a computer.

A one year experiment with commuter dispatch by the Flemish public transport operator. DE LIJN in two low-density areas came to the conclusion that the system has a positive impact on customers. operators, drivers and the organisation as a whole.

F. ADVANCED VEHICLE SAFETY

Approximately 47,000 deaths occur on Europe’s roads each year. Advanced vehicle safety systems have a contribution to make in reducing this toll. Some. like intelligent cruise control, are prototypes of products which will eventually be marketed directly to vehicle owners on the strength of their safety benefits. In other cases the implementation will depend on those who regulate for road and vehicle safetv being sufficiently convinced of the overwhelming worth of the device as a contribution to road safety to make it mandatory.

A distrnction can be made between stand-alone systems (such as vision enhancement) and systems that rely on communication with the roadside or other vehicles (e.g. advance warning of slippery conditions generated by preceding vehicles). Another distinction is sometimes made between passive and active systems depending on whether the system only warns the driver or also intervenes in the control of the vehicle (e.g. by braking).

The systems that are described here have only been tested in small-scale. experimental conditions. In the absence of reliable theoretical models. large-scale pilots are needed to prove system reliability. Several stand-alone systems are now ready for such pilots.

F.l Monitoring

An innovative, electronically scanned, obstacle-waming radar has been developed, which provides both range and lateral information. It gives wide coverage of the road ahead without the need for mechanical scanning techniques. This means that a reliable and cheap version can be mass-produced.

Driver state monitoring using neural networks detecting deviations in vehicle handling has been developed.

F.2 Communications

A special high-fi-equency communication link has been developed and is ready for field testing. This will be used for multi-purpose information transfer between vehicles and the roadside.

F.3 System safety standards

The evaluation and development of safe telematics systems involves both technical and psychological factors. For example, in the case of driver monitoring, objective data on speeds. distances between vehicles and braking times need to be evaluated alongside psycho-physiological criteria like heart rate variability. muscle tone and driver comfort. Much has been done to harmonise the evaluation of psychological factors involved in developing applications. Specific guidelines have been developed for drivers with special needs. Work has also been completed to ensure that all electro-magnetic systems are safe and compatible for use in cars.

F.4 Information displays and Human-Machine Interface (HMI)

Various information delivery methods have been developed Visual communications include Head Up Displays (HUD) Liquid Crystal Displays (LCD). and standard graphical symbols which convey Information in the shortest possible time Auditory messages include tonal and vocal sound effects. Tactile messages Include steering wheel resistance and accelerator vibration. Different driver response mechanisms have also been studied

An in-vehicle information system demonstrator was developed to facilitate the investigation of HMI design Issues.

Design methodologies and guidelines are being produced. incorporating both technical criteria and human factors Glance duration on vehicle displays. stopping distances and driver workload are just some of the key variables which have been studied. Adraft code of practice on the HMI has been endorsed with a recommendation of the ECMT

G. COMMON FUNCTIONS AND CROSS-DOMAIN SUPPORT ACTIONS

Many of the essential common building blocks for RTT are now available, or will be available very shortly. They include:

- Agreement on a basic data dictionary for RTT services
- Standards for digital mapping of road networks, geographical location referencing and the basis for navigational databases
- Pre-standards and protocols for Dedicated Short-Range Communications (DSRC)
- Proposals on message exchange formatting for electronic data transfer
- Successful trials of multi-service/multi-payment applications using smart card and electronic payment mechanisms. including combined use of DSRC.

G.l Open system architecture

Proposals for urban. inter-urban and in-vehicle system architectures have been made by the SATIN task force covering six application areas: collective transport, urban and inter-urban traffic management. fleet and freight management including hazardous goods monitoring, travel and traffic information management and automatic debiting. These results have been passed to the appropriate IS0 and CEN standardisation committees.

G.2 Data exchange

Fundamental to the success of the systems architecture approach is the need for agreement on the means of data exchange between the various parties. The three key technical tools for data exchange are ready (necessary but not sufficient conditions for success), the DATEX data dictionary. the EDIFACT message exchange format. and the ALERT-C location referencing rules. The DATEX task force has produced recommendations which are being taken forward by CEN TC 27X and the Steering Committee for Traffic Centres and Data Exchange Issues.

An organisational architecture has also been proposed by the TELTEN and TELTEN2 projects to exchange information between Traffic Information Centres. Recommendations have also been made for information exchange between adjacent Traffic Control Systems.

G.3 Data dictionary

For data exchange purposes and to develop interoperable systems, a common data dictionary is essential. Technical reports have been prepared as a preliminary step towards reaching agreement on a pre-standard. A distiction should be made between the DATEX data dictionary (used for data exchange). and the ALERT-C message list (used for RDS-TMC) that has become a subset of that data dictionary

G.4 Standards for Road Transport Telematics

Many standards for specific RTT applications are already available in draft status from CEN. CENELEC and ETSI. They can therefore be used for planning and implementation purposes. These results now need to be communicated and widely adopted wherever appropriate as the basis for RTT system design and equipment procurement. Progress has not been achieved uniformly and attention to finalising those standards which serve a key function in the overall RTT implementation is now required. Attention to achieving compatibility and inter-operability with non-standard systems is also necessary.

G.5 Legal and Institutional Issues

In an earlier Communication the Commission identified the following subjects for attention in support of Europe-wide deployment of RTT services. in parallel with standardisation and other technical activities:

- Licensing and franchising of services - public/private partnerships
- development of the information market
- data protection and privacy
- product liability
- procurement and commissioning of services
- intellectual property rights
- regulatory barriers and opportunities
- relationships behveen different level of public authorities.

A number of problems are specific to the road transport sector and have been the subject of reports from ERTICO and the ECMT In addition. an ad hoc group of private sector service providers has suggested priorities for action to promote commercially operated RlT information services

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III. EVALUATION OF ROAD TRANSPORT TELEMATICS APPLICATIONS AND SERVICES

Evaluation is a key element in the process of implementing road transport telematics applications and products. A mixed cost-benefit analysis and multi-criteria appraisal framework for road projects has been developed by the Commission Services (see Annex 2). This framework is designed to accommodate, within a common evaluation structure, the appraisal of both conventional road infrastructure investment and telematics projects.

1. DEMAND MANAGEMENT, TRAFFIC OPERATION AND CONTROL

1.1 Demand Management

Road Transport Telematics can help urban authorities and managers of urban transport strike an efficient balance between the travellers' demand and preferences on the one hand, and the capacity of the transport network on the other. EU-funded research has provided both the technical tools to implement policy, and the analysis to help the management authority to decide on its policy.

The Barcelona access control trials achieved:

- an average 18% reduction of travel time inside the “special events” controlled zone.
- entry volumes before and after access control implementation showed a 33% reduction for the special event zone and a 78% reduction for the priority zone.
- quality of information provided by the public authorities on the pilot implementation of Access Control systems was rated good by 89% of people surveyed.
- for the special events zone an estimated 50% increase in public transport trips city-wide indicates a positive response on modal shift.
- a 50% reduction of emission was also achieved.

Similar trials in Bologna showed a good financial return on investment: the pay-back period was estimated to be between 2 and 5 years. depending on the rate of violations.

1.2 Urban Traffic Operation and Control

Urban Traffic Control Tests of new advanced UTC systems have indicated typical reductions in travel time of 10% with associated savings in fuel consumption and emissions. Pollution control operating by means of UTC and VMS has achieved predicted reductions in emissions of some 26-30% (CO. NO,. HC) in the controlled area under severe pollution conditions At this level of control traffic entenng the central area was reduced by 5%. Pedestrian Traffic Control trials of new microwave detection for pedestrians with new control strategies have achieved improvements for pedestrian safety with a decrease in red light violations and in the number of potential pedestrian-vehicle collisions.

1.3 Inter-Urban Traffic Operation and Control

Various models developed to reflect different operating environments have been applied to test real time VMS control strategy selection and traffic prediction information. The use of these models as part of a re-routing strategy demonstrated the possibility to reduce traffic delays by up to 20% and thus CO by up to 10%. HC by 5% and NO, by 5%.

In another example VMS installation on the motorway to provide park and ride information resulted in an 80% increase of use. Control strategies using metering of traffic on access ramps and VMS increased the mean speed between 16 and 21% and resulted in delay reduction up to 19% for all traffic on the ramps.

Stations using a range of new weather monitoring detectors were tested together with VMS and in-vehicle systems and used to warn drivers of changes in road conditions or to implement speed control. Reductions in vehicle speed up to a 10% were obtained and accidents decreased by more than 30% and the number of people killed or injured by more than 40%.

1.4 Incident Detection and Emergency Management

A number of initiatives have been developed to address public safety and facilitate the means of calling for assistance. Vehicles have been fitted with the latest “emergency call system” utilising the satellite Global Positioning system and digital road map together with GSM for data transmission of the emergency telegram. A reduction in the response time (43%) of emergency vehicles has been measured using these systems with a corresponding increase in casualty survival rate (between 7 and 12 %) and a potential reduction in the long term severity of the injuries.

One of the most promising contributions has been in vehicle detection technology utilising computer vision analysis techniques With a detection rate better than 93% and false alarm rates lower than 8%, the new detection systems. combined with new algorithms, have been used as very effective operator tools that also allow direct visibility of the incidents’ nature.

2. TRAVEL AND TRAFFIC INFORMATION SERVICES

2.1 Acceptance and impacts of HDS-TMC traffic information

All the available results of’ field trials and questionnaire surveys on user acceptance and Impacts of RDS-TMC service have been brought together. A high level of acceptance was confirmed. 70% of the questioned drivers are satisfied or even very satisfied by the service. and 82% consider the received RDS-TMC information as useful or very useful. In one case 34% of the drivers changed route following RDS-TMC messages on congestion, 33% of the drivers reduced speed when approaching the announced incident area, and 92% of the drivers are in favour of an implementation of RDS-TMC in Europe.

2.2 In-vehicle route guidance

Trials on Dynamic Route Guidance (DRG) have not yet provided the basis for a full impact assessment. No trial has had more than 100 equipped vehicles. Evaluation has therefore centred on technical performance of systems and driver response, using a common questionnaire. logbooks and some data from other studies. Answers given by the drivers indicate that DRG is capable of changing their driving habits either by leading them to take different roads or by enabling them to drive at different times. In particular, 55% of the test drivers considered the in-vehicle route guidance useful for travel time reduction. and 38% of these drivers believed that the recommended route was better than their own choice.

Simulation results indicated a 6% reduction in travel time using a decentralised multi-routing strategy. given a 20% market penetration and 100% compliance with guidance advice.

2.3 Public Access Terminals

Portable on line interactive services using standard digital mobile networks, based on real time information have been used successfully to provide a wide range of traveller and public information services including traffic information and hazard warnings; public transport information, and tourist and visitor information. Most people found the terminals easy to use. There was also evidence of a substantial increase in peoples' knowledge about public transport services after using the terminals: 60% of the users said they were influenced by the information provided. 40% changed their departure time, 30% changed the departure date and 20% used an alternative route.

2.4 Road side information

Variable Message Signs (VMS) are currently the only means of presenting information that will be seen by all drivers passing a particular location. Traffic control strategies and decision making processes have been designed and evaluated to ensure important information is presented to the driver using VMS. Typically, in Scotland, a 20% reduction in delays likely to accrue following an accident on the Forth Road Bridge may be expected using VMS. Other savings of 5 to 10 minutes are obtamed when problems occur on other parts of the network. A large majority of those who used the route regularly during the project trials (82% by questionnaire) have indicated that they will follow VMS information even if the information is in conflict with other sources

Trials on the Amsterdam Ring also show the response to VMS. Of those interviewed 80% found the information to be correct; 98% understood what the sign meant; 68% thought there was some improvement in driver comfort and 63% reacted to the information. Using 350 VMS around the Penphenque in Parts established that 80% of the drivers preferred to be informed about travel time rather than queue lengths.

VMS used as part of a weather traffic management system resulted in a 10% speed reduction and up to 30% less accidents in rainy conditions and 85% reduction on foggy days.

3. TOLLING, ELECTIONIC PAYMENT AND BOOKING

In the Third Framework Programme a number of projects dealt with tolling. electronic payment and booking, and provided specification documents for common payment systems.

The technical feasibility of multi-service smart-card based payment systems (for public transport. parking. metro and telephone) has been demonstrated in Marseilles and Dublin -the first time such applications had been put together in an integrated way. A common transponder-based system which demonstrated non-stop multi-lane tolling was also produced (Gothenburg. Thessaloniki and Jonkoping). Urban pricing applications, such as Dynamic Congestion Pricing (Cambridge) and a novel transponder-based parking booking. guidance and debiting system (Lisbon) was demonstrated. One project showed how different debiting and information services can be integrated using a single DSRC. Indeed the multilane debiting and enforcement solution is now used commercially for tolling in Austria.

The performance characteristics of smart cards tested within the ATT Programme were compared and the operators' acceptance of the smart cards was assessed. In most cases the technology deployed worked acceptably. bearing in mind that most equipment was at best advanced prototypes. Usually the current card technology was sufficient for the application(s) deployed. However there is clearly reluctance to implement systems on a large scale until certain barriers to inter-operability have been overcome.

4. COMMERCIAL VEHICLE OPERATIONS

4.1 Freight & Fleet Management

On the basis of EU-funded demonstrations and field trials. freight and fleet management functions should provide saving in travel time close to 5% (trials range 0-1 6.5%) and savmgs in dispatch time above 12% (trials range from -4.2 to 35 2%). Travelled distance should accordingly be reduced by over 6^0 (trials range 0.3-2 1.3%). Other results showed that. usmg Transport Telematics and Mobile Data Communications for freight and fleet management up to 77.5% of the currently wasted time (waiting time, pick-up time. delay time) could be saved and the number of delayed arrivals decreased by 35%

On fuel savings. as a result of' freight & fleet management fuctions an average reduction in cosumption of 2.350 litres per vehicle and year was measured, resulting approximately in a 4 .4% fuel reduction based on 150,000 km year travelled distance and 35l/100 km specific fuel consumption

Estimates have shown that. on average, the use of Mobile Data Communications for Fleet Management applications would lead to a marginal incease of transport cost per vehiclc and km in the amount of only 1 ECU 1000 km Experience with INMARSAT-C satellite communications. used on 32 vehicles at 5 companies. indicated an estimated saving of 2% mileage in international transport with a payback period of 4-8 years

4.2 Intermodal Tracking and Tracing

For Intermodal Tracking and Tracing applications trials showed that the average waiting time for vehicles of the transport fleets was reduced by up to 20%, whilst. for the combined mode. the pick-up and waiting time for switching from road to rail was reduced by hours. The use of Tracking and Tracing systems has also demonstrated a high potential to increase the number of customers served with the same operational resources due to the fact that just-in-time and more efficient operations become possible.

5. COLLECTIVE TRANSPORT SERVICES

5.1 Public Transport Priority

The implementation of Public Transport Priority PT in advanced Urban Traffic Control systems has been supported by a range of vehicle detection/location technologies. including bus transponders with inductive road loops. bus tags with roadside beacons and radio technologies. Savings in delays to buses and trams at signals by giving priority averaged some 50% across all assessments (up to 97% in one application) with negligible impacts on private traffic. Other measured operational benefits included up to 25% reductions in PT journey times and delay variability; and an improvement in the regularity of PT services of up to 11%. Economic cost-benefit analyses indicated very favourable rates of return. with payback periods varying from 3- 16 months.

5.2 Public Transport information

Five projects undertook field tnals utilising real-time bus stop information displays with at least one project using some form of automatic vehicle location technology to up date the information. Some 81% of the users found the at-stop information useful for their journey. and 58% would support further investment A small proportion of users (3.7%) stated they would use public tranport more as a result. but there was no measurable increase in usage. Three of the projects established that the information had reduced passengers' anxiety and allowed them to make alternative arrangements if necessary Passengers' perception both of the service and of the service provider improved significantly

6. ADVANCED VEHICLE SAFETY SYSTEMS

6.1 Driver monitoring

Accident Data recorders have been tried on commercial vehicles for driver monitoring purposes The trials resulted in a statistically significant reduction in accident occurrence (up to a maximum 41% reduction with respect to the historical average of the number of accidents for a fleet of 130 vehicles) and a beneficial reduction in accident costs due to lower accident severity.

At the fleet level. the savings were sufficient to recover the equipment cost within one year. In addition. as a result of reduced accident related damages, repair cost per km decreased up to 40% leading to a greater reduction of total social costs from road accidents (including insurance. hospitalisation and other costs). Surveys of user response suggest that the implementation of a driver monitoring function has a slightly negative impact on driver comfort but a positive assessment of its contribution to better safety.

6.2 Driver Support

Studies have shown that for elderly drivers reversing aids would only marginally affect the willingness to drive to places where parking manoeuvres were known to be difficult. However. the availability of vision enhancement means would allow 60-70% of elderly people to drive more at night.

A majority of the elderly drivers who tested Route Guidance systems for driver support stated that the availability of these systems were likely to lead to a greater number of journeys to unfamiliar places.

In terms of socio-economic aspects. the results of helping Drivers with Special Needs indicate the possibility of achieving a better social integration of this group through the use of driver support systems.

6.3 Collision Avoidance

Collision Avoidance systems have found a good level of acceptance from people that would otherwise suffer some limitation in their ability or willingness to drive (i.e. disabled people in general and elderly driver with respect to congested or unknown areas and limited visibility conditions). In dense fog conditions, collision avoidance systems. though subjected to limited real-life testing. have found widespread good acceptance. assuming that a very low rate of false alarms could be achieved Measurements of the average Headway Time (HT) for normal drivers of private vehicles using collision avoidance systems indicate that the use of collision warning functions resulted in an increased average HT.

6.4 Intelligent Cruise Control

Tests on a driving simulator have shown that intelligent Cruise Control (ICC) systems use can improve safety as a result of a reduction in average vehicle speed (5% for the informative mode) and an increase of average Headway Time (30% for the informative mode). Track tests have indicated an average Headway Time increase of between 5 and 10% (from low to high speed). and a modification of the Headway Time distribution (which showed a reduction at low frequency and an increase at medium frequencies). There was an increase up to 35% of the average time-to-collision for the approaching phase (under stationary speed conditions) On driving comfort it was found that informative-only ICC systems had a worse than average assessment whilst automatic mode ICC was generally thought to contribute to better dnving comfort

7. CROSS-SECTOR CONCERNS

As well as securing benefits specific to each domain, telematics applications need to be assessed for their wider benefits to society. Three important factors are safety. environment and energy.

7.1 Safety

The potential complexity of RTT systems requires that a structured methodology be used to confirm that safety hazards are both recognised and their corresponding requirements are incorporated into the final system. This was recognised within the Third Framework Programme with the creation of the Task Force on evaluation. One project had responsibility within the programme for ensuring that safety evaluation was carried out to the best possible standards and another to produce a proposal for the certification of ATT systems within Europe.

7.2 Environment

Effective use of Variable Message Sign selection strategy was found in one case to reduced delays by up to 20% with corresponding decreases in gas emissions: CO down by 10%. HC by 5% and NOx by 5%.

An advanced predictive environmental model showing the integration of traffic control and VMS. and mcorporating on-line conncetions to meteorological and pollutant measurement stations, has shown reductions in the controlled area of

- 29% in kerbside CO ppm
- 30% in kerbside NOx ppm
- 26% in kerbstde HC ppm

Outside the controlled area. pollutants increased by 13% and total network travel time Increased bv 2%.

In Barcelona. model estimates for access controls in the special events area predicted a 50% reduction of emissions: and In surveys made within the priority zone citizens indicated a perception of reduced air pollution (19%) and reduced noise (20%). Pollution control incorporating UTC and VMS has achieved predicted reductions in emissions of some 26-30% (CO. NOx HC) in the controlled area under severe pollution conditions corresponding to a 5% reduction in traffic entering the central area

7.3 Energy

Reductions in journey time and distance travelled due to improved vehicle routing, as demonstrated by simulated tests with in-vehicle Route Guidance systems, would lead to a reduction in fuel consumption and emissions .

Savings of 4%-6% in fuel consumption and emissions have been reported from one application of enhanced Urban Transport Control with Public Transport priority. Further improvements are possible if modal change is achieved.

Tests of new advanced UTC systems have indicated typical reductions in travel time of 10% with associated savings in fuel consumption and emissions.

ANNEX 1 On-going EU Activities concerning deployment of Road Transport Telematics

Initiative	Description	Timing
TELTENZ	The objectives of TELTENZ are to: Create guidelines for traffic management and information on the Trans-European Road Network; Build consensus amongst Member States; Promote implementation activities at national, Euro-regional and European levels: Identify actions to improve the regulatory framework; Explore opportunities for financing and public/private collaboration: Identify further R&D and standardisation needs.	1/95-3/96
Euro-Regional Projects	CENTRICO. SERTI, VIKlNG. CORVETTE. Euro-regional projects for Implementing traffic management and information services on the Trans-European Road Network, with TEN-Transport Financial support.	1995 (Ongoing)
FORCE	Project to co-ordinate and develop the demonstration of IDS-TMC projects in 10 Member States.	1996 (Ongoing)
ECORTIS	Study on the European coordination for the implementation of the RDS-TMC traffic information services.	end95-end 98
RDS-TMC Steering Committee	Group of national representatives co-ordinating policy and strategy for RDS-TMC traffic information services.	11/94 (Ongoing)
EDEN	Feasibihty study on the European Data Exchange Network between traffic information centres on the trans-European road network.	end95-end 96
Traffic centrcs Steering Committee	Group of nabonal rcpresentatives co-ordinating policy and strategy for traffic ccntres and data exchange Issucs.	1/96 (Ongoing)
INFO 2000	A four year programme to assist the implementation of an information services market; to stimulate and reinforce the competitive capability of European suppliers of information services.	1996-99
RTT Service Providers Group	Ad hoc group of private sector providers of travel and traffic information services looking at requirements for commercial RTT services. Report May 1996 submitted to High Lcvcl Group on RTT with recommendations.	6/95 (Ongoing)
CARD-ME	CARD-ME is a joint DG VII - DG XIII action aimed at harmonising automatic fee collection (AFC) systems in Europe.	7/94 (Ongoing)
Information Society Forum	Twice Yearly gcncral assembly of approx. 120 representatives of Telematics user groups. network operators, academia, social partners, parliamentarians, professions, information, service providers. Working Group 3 (the influence of telematics for Public services) is studyng the state of play in the transport sector, with a view to making rccommcndatlons.	1996 (Ongoing)

ANNEX 2 Framework for Evaluation of Road Transport Telematics

Road Transport Telematics can be evaluated against a number of different criteria. Different kinds of evaluation are necessary for different hinds of applications. For investments within the public domain, for instance, the emphasis is on impact assessment and cost-benefit analysis. For investments by the private sector. the emphasis is on user acceptance and market potential.

- Technical evaluation: this type of evaluation involves testing whether applications function properly, i.e. according to the specified technical specifications.

  Impact assessment. the impact of an application can be measured in terms of safety (e.g measured by the reduction in the number of casualties and seriously injured). time-efficiency (e.g. measured by the reduction in number of person-hours of travel time) and comfort (e.g. measured by how well users are informed).

  Cost-benefit analysis. this kind of analysis is wider than an impact assessment, it evaluates the net overall effects (positive and negative) of the introduction of an application on a society; monetary values are given to the overall costs and benefits expected as a result of the introduction of an application; benefits not only include safety. time-efficiency and comfort but also employment and pollution.

- Market potential this is concerned with how many applications can be sold to target markets. and at what price

- User acceptance it is established. based on relevant attributes of an application to what extent users like or dislike different aspects of an aplication

  Financial analysis here. only monetary flows are analysed; the concern IS what extra costs are incurred . and what financial revenues are generated by the introduction of an application: note that an application can have a positive result based on cost-benefit and yet be not financially feasible